P-ISSN : 2579-969X ; E-ISSN : 2622-7940

COMPARATIVE OF EXCISE STAMP PROCUREMENT USING EOQ AND JIT METHODS

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Abstrak

Penelitian ini bertujuan untuk membandingkan efisiensi metode Economic Order Quantity (EOQ) dan Just in Time (JIT) dalam pengadaan pita cukai pada PR. Bako Gayo, sebuah pabrik rokok yang beroperasi di Aceh Tengah. Penelitian ini menggunakan pendekatan deskriptif kuantitatif dengan data yang diperoleh melalui dokumentasi dari sistem SAC Online, kemudian dianalisis menggunakan model EOQ dan JIT untuk menghitung jumlah pemesanan optimal, frekuensi pemesanan, dan total biaya persediaan. Hasil penelitian menunjukkan bahwa metode EOQ menghasilkan total biaya persediaan sebesar Rp 259.272,73, sedangkan metode JIT menghasilkan biaya yang jauh lebih rendah sebesar Rp 97.995,88. Temuan ini menunjukkan bahwa metode JIT lebih efisien karena mampu menekan frekuensi pemesanan dan biaya penyimpanan serta memastikan kepatuhan terhadap regulasi cukai. Hasil ini sejalan dengan penelitian empiris sebelumnya yang menegaskan keunggulan JIT dalam mengoptimalkan manajemen persediaan pada kondisi inflasi dan regulasi yang ketat. Berdasarkan hasil penelitian, disarankan agar PR. Bako Gayo menerapkan metode Just in Time (JIT) sebagai strategi utama pengadaan pita cukai karena terbukti lebih efisien dibandingkan metode EOQ. Penerapan JIT perlu didukung dengan koordinasi yang kuat dengan pemasok dan sistem pemantauan persediaan digital terintegrasi untuk menjaga kelancaran produksi serta kepatuhan terhadap regulasi cukai. Secara teoretis, penelitian ini memperluas kajian manajemen persediaan pada industri yang diatur secara ketat serta memberikan implikasi praktis dan kebijakan untuk meningkatkan efisiensi di sektor industri tembakau.
Kata Kunci: *Economic Order Quantity (EOQ), Just in Time (JIT), manajemen persediaan, pita cukai, efisiensi biaya*

Abstract

This study aims to compare the efficiency of the Economic Order Quantity (EOQ) and Just in Time (JIT) methods in managing the procurement of excise stamps at PR. Bako Gayo, a cigarette factory in Central Aceh. Using a quantitative descriptive approach, data were obtained through documentation from the SAC Online system and analyzed using EOQ and JIT models to calculate optimal order quantity, order frequency, and total inventory cost. The results show that the EOQ method produced a total inventory cost of Rp 259,272.73, while the JIT method resulted in a significantly lower cost of Rp 97,995.88. These findings indicate that JIT provides greater cost efficiency by minimizing order frequency and holding costs while ensuring compliance with excise regulations. The results confirm previous empirical research highlighting the superiority of JIT in optimizing inventory management under inflationary and regulatory constraints. Based on the research findings, it is recommended that PR. Bako Gayo implement the Just in Time (JIT) method as the primary strategy for procuring excise stamps, as it has proven to be more efficient than the EOQ method. The implementation of JIT needs to be supported by strong coordination with suppliers and an integrated digital inventory monitoring system to ensure smooth production and compliance with excise regulations. This study contributes theoretically by extending inventory management analysis to regulated industries and provides practical and policy insights for improving efficiency in the tobacco sector.
Keywords: *Economic Order Quantity (EOQ), Just in Time (JIT), inventory management, excise stamps, cost efficiency*

1. INTRODUCTION

Inflation is an economic phenomenon that describes the condition of a general and sustained increase in prices across various groups of goods and services consumed by the public, not limited to just one type of commodity (Suparmono, 2018). Based on data published by Bank Indonesia (2025), Indonesia has experienced an inflation trend in recent years. In 2022, the inflation rate was recorded at 4.21%, then decreased to 3.69% in 2023, and further experienced a significant decline to 2.3% in 2024. Although the inflation rate has shown a downward trend over the past three years, the impact caused by inflation remains a concern and needs to be anticipated wisely.

Inflation negatively impacts the economy, especially with the decrease in people's purchasing power due to rising prices of goods and services. This condition forces people to reduce consumption because their income does not increase. As a result, demand for products decreases and the growth of the industrial sector slows down. Business operators must also adjust production costs and formulate strategies to cope with the surge in raw material and operational prices (Rofiqoh *et al*., 2025).

PR. Bako Gayo, as a cigarette factory operating in Central Aceh Regency, also feels the impact of inflation affecting various aspects of its operations. In facing such conditions, the company strives to cut costs, one of which is through more efficient inventory management. Inventory management becomes important because it can help determine the cost of goods sold accurately and ensure the smooth flow of goods, especially those obtained from suppliers (Utama *et al*., 2019). As a cigarette industry, the inventory of excise stamps is a crucial component that needs to be planned meticulously because it directly impacts production costs.

To improve the cost efficiency of procuring tax stamps, the EOQ and JIT methods can be applied. Both methods have calculations to determine the amount of inventory costs needed. EOQ emphasizes determining the optimal inventory quantity to ensure smooth production (Utama *et al*., 2019), while JIT prioritizes ordering inventory only when it is truly needed.

Previous studies have discussed EOQ and JIT methods separately in general manufacturing industries, but few have examined their application in the cigarette industry, particularly in the procurement of excise stamps, which have high regulatory and administrative risk characteristics. In addition, comparative studies between EOQ and JIT in the context of cost efficiency under inflationary conditions are still limited. This study fills this gap by analyzing the comparative efficiency of the two methods in the procurement of excise stamps at PR. Bako Gayo.

The novelty of this study lies in the comparative application of EOQ and JIT to exercise stamp inventory, which differs from previous studies that generally focused on raw materials or finished products. In addition, this study includes the variable of inflation as an external factor that affects cost efficiency and presents a unique empirical case from the local cigarette industry in Aceh, thereby expanding the context of the application of inventory management theory in a more specific economic and sectoral context.

Theoretically, this study enriches the literature on the effectiveness of EOQ and JIT methods in the context of a fluctuating economy and regulatory inventory types. Practically, the results of this study provide a basis for decision-making for companies, especially in the cigarette industry, to determine the most efficient procurement method amid inflationary pressures. From a policy perspective, this study provides input for relevant authorities, such as the Directorate General of Customs and Excise, in improving the efficiency of excise stamp distribution and supporting the resilience of medium-scale tobacco industries in the regions.

Based on the above explanation, the researchers are interested in conducting a study that compares the application of the EOQ and JIT methods in the procurement of excise stamps at PR. Bako Gayo. This interest arises from the limited research on inventory management within the cigarette industry, particularly for excise stamp procurement that is highly regulated and sensitive to inflationary pressures. Through this study, the researchers aim to determine which method—EOQ or JIT—can provide greater cost efficiency under fluctuating economic conditions, thereby offering both theoretical insights and practical solutions for improving inventory management performance in regulated manufacturing sectors.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

A. Inventory Management

Inventory management is a vital component of a company's operations, playing a role in regulating the storage and management of goods to optimally meet customer demand. The primary goal of inventory management is to strike a balance between product availability and operational cost efficiency (Saragih, 2024).

In this context, the concept of trade-off becomes crucial, namely the balance between storage costs and the cost of stockouts. Storage costs include all expenses related to storage activities, such as warehouse costs, insurance, maintenance, and depreciation of goods. Conversely, stock-out costs encompass losses incurred due to unmet customer demand, such as lost sales, customer dissatisfaction, or additional costs from emergency orders.

B. Excise Stamps

Excise stamps are a special document used as proof that the tax on an item has been paid or settled. This document is printed in physical form on paper equipped with certain security elements or features. The excise tax stamp has a special design and specifications to prevent counterfeiting. Generally, tax stamps are affixed to the packaging of cigarette products or alcoholic beverages as proof that the tax has been paid (Directorate General of Customs and Excise of the Republic of Indonesia, 2021). Here are the types of excise stamps:

Table 1. Types and Specifications of Excise Stamps

Series	Number of Stamps / Sheets	Size / Stamp	Usage
I	120	1,2 cm X 11,7 cm	SKT, SPT, SKTF, SPTF, KLB, KLM, CRT, and TIS produced in Indonesia or imported for use within the customs territory
II	56	1,7 cm X 17,7 cm	
III TP	150	2,3 cm X 4,8 cm	SKM, SPM, CRT, REL, and HPTL with retail packaging in forms other than bottles, cans, and similar containers, as well as for TIS types imported for use within the customs territory
III DP	60	1,9 cm X 7,4 cm	SKM, SPM, CRT, REL, and HPTL with retail packaging in the form of bottles, cans, and similar containers

Source: Directorate General of Customs and Excise of the Republic of Indonesia (2021)

C. Economic Order Quantity (EOQ) Method

The EOQ model is one of the oldest and most widely used methods in inventory management. Its main purpose is to help companies decide the best order size that balances two costs: the cost of placing an order (administration, procurement, transportation) and the cost of holding inventory (storage space, insurance, maintenance). If a company orders too often in small quantities, ordering costs will increase. On the other hand, if a company orders large quantities but less frequently, holding costs will rise. EOQ finds the point where these two costs are minimized.

In practice, EOQ works best when demand is predictable and stable. That is why it is often combined with other tools like the ABC inventory classification, where “A” items (high value) get tighter monitoring and “C” items (low value) get simpler controls. This helps managers focus attention on the most important materials. However, EOQ also has its limitations, because it assumes constant demand and fixed ordering costs. In real business situations, demand can change, and costs may vary, so EOQ needs to be adjusted to actual company conditions.

For sensitive or regulated items, such as excise stamps, the EOQ method can be less flexible. Although it ensures a balance between order size and cost, it may create overstock risks when the items have expiration dates or strict usage limits. Therefore, companies often need to complement EOQ with other systems,

like tighter stock monitoring or computerized inventory systems, to ensure the order quantity stays accurate over time (Saragih, 2024).

D. Just In Time (JIT) Method

The Just in Time (JIT) system is an inventory management and production approach designed to reduce or even eliminate waste by ensuring that materials arrive exactly when they are needed in the production process. According to the source, JIT is not only about reducing inventory, but also about improving the overall efficiency of operations. By applying JIT, companies are encouraged to minimize storage, transportation, waiting times, and overproduction, all of which are forms of waste that increase costs without adding value.

The main idea of JIT is to create a production flow that is closely linked to customer demand. Goods are produced only in the required quantity and at the required time, so inventory levels can be kept very low. This approach allows companies to lower holding costs significantly, improve product quality through tighter process control, and increase flexibility in responding to changes in demand.

However, successful implementation of JIT requires several conditions. Companies must have reliable suppliers, efficient logistics, and accurate demand forecasting. Even small delays or errors in the supply chain can disrupt production because JIT eliminates buffer stock. Therefore, JIT works best in environments where coordination between suppliers and manufacturers is strong, and where production systems are designed to be flexible and responsive.

In the context of industries with strict regulations, such as the use of excise stamps, JIT is particularly relevant. Since excise stamps cannot be stockpiled in large quantities and must comply with regulatory timelines, ordering them on a JIT basis reduces the risk of expired or unused stock while also lowering costs. Thus, JIT not only enhances efficiency but also supports compliance and accountability in regulated sectors (Utama *et al*., 2019).

E. Profile of PR. Bako Gayo

PR Bako Gayo is a cigarette factory located in Central Aceh that was established to revive and utilize local Gayo tobacco. The idea came from Ibnu, who saw that even though Gayo tobacco was known for its quality, most local smokers still consumed cigarettes from outside the region. To change this, he worked with local farmers in Bintang and Lut Tawar districts to cultivate, harvest, and process Gayo tobacco into raw materials for cigarette production (Tribun Gayo, 2023).

To strengthen the supply chain, a producers' cooperative called Koperasi Produsen Bintang Bako Gayo was formed. This cooperative gathered several farmer groups so that tobacco cultivation could run more sustainably. With support from the Agricultural Office and Customs Office in Lhokseumawe, PR Bako Gayo then pursued formal legalization. In 2019. The team visited Cirebon, West Java, to learn cigarette production techniques such as rolling, blending, and packaging (Media Center Bea Cukai, 2020).

On April 9, 2020, PR Bako Gayo officially launched two cigarette products, Ekspansi Gayo and Hill Gayo. It also became the first legal cigarette factory in Aceh to receive an NPPBKC license from Customs Office and contributed around Rp 53.8 million in excise tax revenue. In 2020, the Lhokseumawe Customs Office visited the factory to observe production processes, including raw material handling, excise stamp application, and packaging. This visit showed how PR Bako Gayo had successfully transitioned from traditional processing to a legal and regulated operation (Tribun Gayo, 2023).

F. Hypothesis

Based on the types of research mentioned above, this study develops a hypothesis to compare the Economic Order Quantity (EOQ) method and the Just in Time (JIT) method in calculating inventory costs. The first study, conducted by Bekti & Herdiman (2024) at PT. Petrokimia Gresik, found that the inventory cost of the auxiliary material NaOH was more efficient when using the JIT method compared to the EOQ method. This indicates that JIT can minimize total inventory costs by reducing unnecessary stock and optimizing the timing of procurement (Bekti & Herdiman, 2024).

Further evidence is provided by Gusniar *et al*. (2022) at PT. XYZ, who found that the JIT method was more effective in controlling inventory costs for Lever Assy Parking Brake raw materials compared to the company's existing policy and the EOQ method (Gusniar *et al*., 2022). Similarly, research by Al Rafi *et al*. (2024) at the H. Burhanuddin Sumedang Tofu Factory revealed that soybean raw

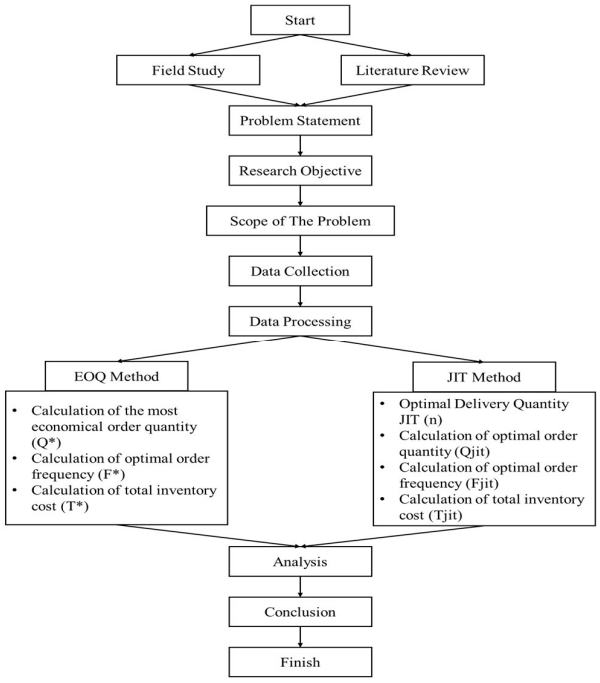
material inventory costs were lower under the JIT method than when using traditional or EOQ approaches (Al Rafi *et al*., 2024). Supporting this, Arindi *et al*. (2024)at PT. Kerta Mulya Saripakan also found that inventory costs for chicken feed raw materials were significantly reduced through the application of the JIT method compared to both the company's actual calculations and the EOQ method (Arindi *et al*., 2024).

Based on these previous studies, the hypothesis research is: "The use of the Just In Time (JIT) method in the procurement of excise stamps at PR. Bako Gayo results in lower total inventory costs compared to the use of the Economic Order Quantity (EOQ) method, thus the JIT method is considered more efficient in managing excise stamp inventory as part of efforts to optimize production costs."

3. RESEARCH METHODS

The type of research applied in this study is quantitative descriptive research, which is designed to describe and analyze numerical data in a systematic way. This method was selected because it allows the researcher to present inventory-related figures objectively while also identifying patterns and levels of efficiency in managing excise tax stamps. Data collection was carried out through documentation by gathering records already available in the SAC Online application from the accounts of PR. Bako Gayo. The use of this documentation ensures that the data is accurate, consistent, and directly connected to the company's actual operational activities.

A literature study was also conducted to provide theoretical and regulatory support, including references from the Directorate General of Customs and Excise on excise stamp management and academic sources on EOQ and JIT inventory control systems. The research focuses on excise stamps used by PR. Bako Gayo under the anonymized label "brand X," allowing evaluation of how inventory methods affect cost efficiency and regulatory compliance. Data analysis employs the EOQ and JIT methods to determine total inventory cost (Simanjuntak & Silitonga, 2024).



Source: Compiled by Author (2025)

Figure 1. Research Framework

A. Calculation of Ordering and Holding Costs for Raw Materials:
   1. Ordering Cost (S)
   $$S = \frac{Op}{Fp}$$
   2. Holding Cost (H)
   $$H = \frac{Os}{D}$$
B. Calculation using the EOQ method:
   1. Calculation of the most economical order quantity (Q*)
   $$Q* = \sqrt{\frac{2\,S\,D}{H}}$$
   2. Calculation of optimal order frequency (F*)
   $$F* = \frac{D}{Q*}$$
   3. Calculation of total inventory cost (T*)
   $$T* = \frac{D}{Q*}S + \frac{Q*}{2}H$$
C. Calculation using the JIT method:
   1. Optimal Delivery Quantity JIT (n)
   $$n = \left(\frac{Q*}{2a}\right)^2$$
   2. Calculation of optimal order quantity (Qjit)

$$Qjit = \sqrt{n}\ x\ Q*$$

3. Calculation of optimal order frequency (Fjit)

$$Fjit = \frac{D}{Qjit}$$

4. Calculation of total inventory cost (Tjit)

$$Tjit = \frac{1}{\sqrt{n}}\ x\ T*$$

Notes:

S	: Cost of ordering each time an order is placed
H	: Cost of storing each piece of excise tape
Op	: Ordering Cost
Os	: Holding Cost
Fp	: Frequency of Orders per Year
D	: Raw material requirement in one year
n	: Optimal delivery quantity JIT
Q*	: Optimal order quantity (EOQ)
Qjit	: Optimal order quantity (JIT)
F*	: Optimal order frequency (EOQ)
Fjit	: Optimal order frequency (JIT)
T*	: Total Inventory Cost (EOQ)
Tjit	: Total inventory cost (JIT)

The results of the calculations using both methods will be analyzed for a cost efficiency comparison required by PR. Bako Gayo for the procurement of excise stamps, which is the subject of the research. The results will be entered into a table showing the optimal order quantity, optimal order frequency, and total inventory cost of each method to facilitate analysis.

4. RESULTS AND DISCUSSION

A. Data on the Usage and Ordering of Raw Materials

Below is the data on the usage and ordering of excise stamps by PR. Bako Gayo during the excise stamp year 2022. Calculation of Ordering and Holding Costs for Raw Materials

1. Ordering Cost (S)
   The order frequency is 10 times and the Ordering Cost in one year is Rp 500,000

$$S = \frac{Op}{Fp}$$

$$S = \frac{Rp\ 500{,}000}{10}$$

$$S = Rp\ 50{,}000$$

2. Holding Cost (H)
   The replacement cost of excise stamps as regulated by the Directorate General of Customs and Excise of the Republic of Indonesia (2019), the replacement cost of series I cigarette excise stamps is Rp 25. This cost is referred to as the raw material cost of excise stamps (per piece). In companies, they usually express storage costs as a percentage of the inventory value over a specific period. Typically, the annual cost of storing one unit of inventory ranges from 15% to 35% of its value (Krajewski *et al*., 2018). Therefore, it is assumed that the Storage Cost is 20% of the Inventory Value.

$$H = \frac{Os}{D}$$

$$H = \frac{20\%\ x\ Rp\ 25\ x\ 134{,}400}{134{,}400}$$

$$H = Rp\ 5$$

B. Calculation using the EOQ method (Simanjuntak & Silitonga, 2024):

1. Calculation of the most economical order quantity (Q*)
   Based on the regulations of the Directorate General of Customs and Excise of the Republic of Indonesia (2018), the minimum provision (in this study referred to as ordering) of excise stamps is 10 sheets (each sheet contains 120 pieces) and is applicable in multiples of 10. So, it can be said that the quantity of ordering excise stamps must be in multiples of 1200.

$$Q* = \sqrt{\frac{2\ S\ D}{H}}$$

$$Q* = \sqrt{\frac{2\ x\ Rp\ 50{,}000\ x\ 134{,}400}{Rp\ 5}}$$

$$Q* = 51{,}845.93\ Pieces$$

$$Q* = 52{,}800\ Pieces$$

$$(roundedup, multiples\ of\ 1200)$$

2. Calculation of optimal order frequency (F*)

$$F* = \frac{D}{Q*}$$

$$F* = \frac{134{,}400}{52{,}800}$$

$$F* = 2.55$$
$$F* = 3\ x\ (rounded\ up)$$

3. Calculation of total inventory cost (T*)

$$T* = \frac{D}{Q*}S + \frac{Q*}{2}H$$
$$T* = \frac{134{,}400}{52{,}800}(Rp\ 50{,}000) + \frac{52{,}800}{2}(Rp\ 5)$$
$$T* = Rp\ 127{,}272.73 + Rp\ 132{,}000$$
$$T* = Rp\ 259{,}272.73$$

C. Calculation using the JIT method:

1. Optimal Delivery Quantity JIT (n)

$$n = \left(\frac{Q*}{2a}\right)^2$$
$$n = \left(\frac{52{,}800}{2\ x\ 10{,}510}\right)^2$$
$$n = 6{,}31$$
$$n = 7\ x\ (rounded\ up)$$

2. Calculation of optimal order quantity (Qjit)

$$Qjit = \sqrt{n}\ x\ Q*$$
$$Qjit = \sqrt{7}\ x\ 52{,}800$$
$$Qjit = 139{,}695{,}67$$
$$Qjit = 140{,}400\ pieces\ (roundedup, multiplesof 1200)$$

3. Calculation of optimal order frequency (Fjit)

$$Fjit = \frac{D}{Qjit}$$
$$Fjit = \frac{134{,}400}{140{,}400}$$
$$Fjit = 0.95$$
$$Fjit = 1\ x\ (rounded\ up)$$

4. Calculation of total inventory cost (Tjit)

$$Tjit = \frac{1}{\sqrt{n}}\ x\ T*$$
$$Tjit = \frac{1}{\sqrt{7}}\ x\ Rp\ 259{,}272.73$$
$$Tjit = Rp\ 97{,}995{,}88$$

D. Analysis

Table 2. Inventory Cost Calculation Results

Components	EOQ	JIT
Optimal Order Quantity	52,800 pieces	140,400 pieces
Order Frequency	3 times	1 time
Inventory Cost	Rp 259,272.73	Rp 97,995.88

Source: Compiled by Author (2025)

The results of the inventory cost calculations presented in Table 3 show a distinct difference between the Economic Order Quantity (EOQ) and Just in Time (JIT) methods in managing excise stamp inventory. Under the EOQ method, the optimal order quantity was 52,800 pieces, requiring three order cycles during the observed period and resulting in a total inventory cost of Rp 259,272.73. In contrast, the JIT method produced a larger optimal order quantity of 140,400 pieces but required only a single order cycle. Despite the larger quantity per order, the JIT method achieved a significantly lower total inventory cost of Rp 97,995.88. This finding indicates that JIT not only reduces the frequency of ordering but also minimizes costs associated with storage, handling, and order processing.

These results confirm the theoretical premise that JIT enhances efficiency by synchronizing procurement with actual production needs, thereby reducing unnecessary inventory and holding costs. For excise stamps—items bound by regulatory timelines and expiration—this synchronization is particularly beneficial, as it prevents overstocking and potential financial loss due to expired materials. The findings of this study are consistent with previous empirical research (Bekti & Herdiman, 2024; Gusniar *et al*., 2022; Arindi *et al*., 2024), which also reported that JIT yields lower total inventory costs compared to EOQ. Therefore, the hypothesis (H1) stating that the JIT method is more efficient than the EOQ method in excise stamp procurement is supported. In conclusion, JIT proves to be a more suitable inventory management approach for regulated industries such as tobacco manufacturing, as it promotes both cost efficiency and compliance with government requirements.

5. CONCLUSION

This study compared the efficiency of the Economic Order Quantity (EOQ) method and the Just in Time (JIT) method in the procurement of excise stamps at PR. Bako

Gayo. The results show that the EOQ method produced a total inventory cost of Rp 259,272.73, while the JIT method resulted in a significantly lower cost of Rp 97,995.88. The difference in cost savings of more than Rp 161,000 clearly indicates that JIT provides superior efficiency compared to EOQ in this specific context. These findings confirm the research hypothesis and are consistent with previous studies that highlight the advantages of JIT in reducing storage costs, order frequency, and overall inventory-related expenses.

Beyond cost efficiency, the analysis also demonstrates that JIT offers practical benefits for managing excise stamps, which are subject to regulatory requirements and expiration rules. By synchronizing procurement with actual production needs, JIT minimizes the risks of overstocking, unused inventory, and potential financial losses due to stamp expiration. In contrast, EOQ, although theoretically useful in balancing order and holding costs, tends to generate higher recurring expenses and is less adaptable when inventory is time-sensitive or strictly regulated.

Based on the findings, it is recommended that PR. Bako Gayo adopt the Just in Time (JIT) method as the primary strategy for excise stamp procurement, as it has demonstrated superior cost efficiency compared to the Economic Order Quantity (EOQ) method. The successful implementation of JIT requires strengthened coordination with suppliers and reliable delivery scheduling to prevent production disruptions. Furthermore, the company should develop an integrated digital inventory monitoring system within the SAC Online platform to enhance the accuracy of tracking excise stamp usage, ordering schedules, and stock levels while ensuring compliance with the regulations of the Directorate General of Customs and Excise.

From a broader perspective, government authorities, particularly the Directorate General of Customs and Excise, are encouraged to facilitate flexible order scheduling and digital tracking mechanisms to support small and medium-scale tobacco industries in improving efficiency and maintaining regulatory compliance. Future research is advised to extend the comparative analysis of EOQ and JIT methods to other inventory components—such as raw tobacco or packaging materials—by incorporating variables like lead time variability, supplier reliability, and digital supply chain integration to further strengthen the empirical foundation of JIT applications in regulated manufacturing sectors.

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